UNIVERSITY OF VIRGINIA
DEPARTMENT OF NUCLEAR ENGINEERING AND ENGINEERING PHYSICS
NUCLEAR REACTOR FACILITY
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January 24, 1984

Director, Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attention: Mr. Cecil O. Thomas

Gentlemen:

We hereby submit, as required by Section 6.6.2 of the Technical Specifications, our annual report of the operations of the University of Virginia Reactor (UVAR), License Number R-66, Docket number 50-62 and the CAVALIER Reactor, License Number R-123, Docket Number 50-396 during the period January 1, 1984 through December 31, 1984.

A. UVAR Reactor

The UVAR reactor was operated during the year as follows:

	Hours Operated	MW Hours
First Quarter	715.75	1262.14
Second Quarter	848.0	1539.81
Third Quarter	1071.5	1969.57
Fourth Quarter	531.0	915.87
Total	3166.25	5687.39

1.0 Rod Drop Tests and Visual Inspection

Technical specification requirements:
Rod drop times measured at least semi-annually
magnet release < 50 msec
free drop time < 700 msec
Rod visually inspected at least annually

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Rod drop tests were made on the UVAR reactor as follows:

Date	Rod	Magnet current (ma)	Rod Position (inches)	Magnet release (msec)	Free Drop (msec)	Total (msec)
1-25-84	1	160	26	21.7	458.9	480.6
	2	160	26	39.3	467.7	507.0
	3	60	26	49	566	615.0
3-13-84	Replaced Rod #3					
	3	60	26	35	458	493
4-17-84	1	160	26	17.3	485	502.3
	2	160	26	22.8	470	492.8
	3	60	26	21.3	449	470.3
5-8-84	1	160	26	15.0	473	488
	2	160	26	37.0	471	508
	3	70	26	13.0	455	468
8-27-84	1	160	26	7	502	509
	2	160	26	30	476	506
	3	70	26	19	461	480
11-6-84	1	160	26	18.4	495	513.4
	2	160	26	29.7	476	505.7
	3	70	26	41.6	594	635.6

The rod drop times continue to be within the limits required by the Technical Specifications

The UVAR control rods were visually inspected twice during the year. The following is abstracted from the reactor log book.

Date 5-8-84

Rod #1 - Visually inspected rod under approximately 1 1/2 feet of water. Dose rate at surface of water approximately 750 mr/hr. Some rub marks at top of rod. No evidence of cracking. Passes 0.950 inch gage easily.

Rod #2 - Visually inspected rod under approximately 1 1/2 feet of water. Dose rate at surface of water approximately 500 mr/hr. No evidence of cracking. 0.950 inch gage passes easily.

Rod #3 - Visually inspected rod under approximately 1 1/2 feet of water. Dose rate at surface of water approximately 1 R/hr. No evidence of cracking. 0.950 inch gage passes easily.

Date 11-5-84

Rod #1 - Visually inspected rod under approximately 3 feet of water. Dose rate at surface of water approximately 35 mr/hr. No evidence of cracking. No rub marks. 0.950 inch gage passes easily.

Rod #2 - Visually inspected rod under approximately 3 feet of water. Dose rate at surface of water approximately 17 mr/hr. No evidence of cracking. 0.950 inch gage passes easily.

Rod #3 - Visually inspected rod under approximately 3 feet of water. Dose rate at surface of water approximately 35 mr/hr. No evidence of cracking. 0.950 inch gage passes easily.

Regulating Rod - Visually inspected rod under approximately 3 feet of water. Dose rate at surface of water approximately 17 mr/hr. Rub marks along side and top of rod. 1.00 inch gage passes easily.

2.0 Maintenance Operations

The following maintenance was performed on the UVAR system during the calendar year 1984.

1-6-84 Noise spikes on Power Range Channel #2. Replaced detector and cable connectors. System checked out o.k.

1-26-84 Linear channel noisy. Replaced detector. System checked out o.k.

1-30-84 Spurious period scram on Intermediate Range Channel. Replaced connectors on detector. System checked out o.k.

2-22-84 Compensating voltage to linear channel not functioning properly. Replaced compensating voltage cable from console to reactor bridge. System checked out o.k.

3-13-84 Indication that rod #3 may be rubbing inside guide tube. Disassembled and replaced rod #3. Magnet release time measured to be 35 msec compared to 49 msec measured on 1-25-84.

5-7-84
5-8-84 Drained and cleaned cooling tower and secondary side of heat exchanger as part of yearly preventative maintenance.

6-11-84 Noise in area radiation monitor (reactor bridge) caused two spurious scrams. Exchanged reactor bridge detector with demineralizer room detector. System functioning properly.

7-16-84 a) Power Range #1 noisy. Replaced detector and connectors. Checks o.k.
b) Demineralizer pump noisy. Found badly worn coupling insert. Replaced insert and put system back into operation.

7-19-84 Small leak in outlet piping from demineralizer pump prior to entering carbon filter. Epoxyed area and put system back into operation.

7-23-84 UVAR Room Argon Monitor - background reading unusually high when performing check-list. Checked system and found bad detector. Replaced detector. System functioned normally.

9-12-84 Regulating Rod would not respond to servo control. Cleaned and lubricated lead screw. Replaced capacitor. System functioned normally.

9-21-84 Leak in demineralizer system overnight causing reactor pool
9-25-84 level to drop approximately 1 foot until float switch secured entire system. Contaminated water in demineralizer room and heat exchanger room. De-contaminated areas. Replaced piping from discharge side of pump to carbon filter. Adjusted float switch to secure demineralizer if pool level drops 1-2 inches. Put system back into operation. No leaks detected.

9-24-84 Power Range channel #2 noisy. Replaced detector and connectors. System checked out o.k.

10-8-84 Reactor Room truck door gasket cracked at top of door. Replaced gasket.

10-9-84 Demineralizer Room area monitor - small variations in readings. cleaned connectors on detector. Functions normally.

10-18-84 Constant Air Monitor - Vacuum pump making excessive noise, suggesting bad bearings. Replaced pump-motor assembly and intake and exhaust filters. Functions normally.

11-9-84 Pool Level Demineralizer Trip System - added second back-up float switch to existing system in series with existing switch. New system will also sound alarm in hallway outside reactor room to alert personnel when room is not occupied.

11-27-84 Intermediate Range Channel - Oscillating noise in level and period circuits from H.V. power supply. Found interference from battery charger for Pneumatic Rabbit system feeding through primary side of H.V. power supply. Connected Battery charger to different circuit. Noise eliminated.

12-5-84 Power Range #2 erratic. Replaced detector - system checks out o.k.

12-20-84 Source Range Channel - erratic signal. Found bad - 6 volt power supply to pre-amp. Installed temporary 6 volt battery to pre-amp until permanent power supply can be replaced. System checked out o.k.

3.0 Operating Procedures

The UVAR standard operating procedures were revised during the year as follows:

January, 1984 - Section 12 (Emergency Procedures) was revised and expanded.

February, 1984 - Section 5 concerning start-up procedures was expanded.

March, 1984 - Section 6 concerning sample irradiations was expanded.

July, 1984 - Section 7.4 concerning control rod calibration was revised and expanded.

October, 1984 - Section 10.4 concerning Health Physics surveys was revised.

December, 1984 - Section 6 concerning sample irradiations was expanded.
Section 10 concerning liquid releases was expanded.
Section 12 changes were made to the "Emergency Actions" list.

These changes were reviewed and approved by the Reactor Safety Committee.

4.0 Experiments

a) A broad program of activation and analysis work was done during the year for the Departments of Nuclear Engineering and Engineering Physics, Chemistry, Radiology and the Clinical Chemistry Laboratory of the U.Va. Hospital.

b) A series of experiments were performed during the year for the Electric Power Research Institute involving radiation damage studies of pressure vessel samples. Nine different capsules were run during the year. These experiments were terminated in October 1984.

c) A series of experiments were performed during the year for the Carolina Power and Light Company that involved the study of degradation in fiberglass insulation due to radiation and high temperature.

d) A continuing program of tobacco research was performed for the Philip Morris Company.

e) A series of neutron radiography experiments were performed during the year utilizing the neutron beam ports.

f) The south tangential beam port facility was used during the year to measure photo-fission cross sections utilizing a centrifuge.

g) The following Academic Institutions utilized the facility for tours and activation analysis experiments.

1) Virginia Institute of Marine Science
2) Mary Washington College
3) Brandeis University
4) James Madison University
5) Junior Science Symposium
6) Longwood College
7) Lynchburg College
8) Bridgewater College
9) University of S. Carolina
10) Rappahanock High School
11) Fairfax High School
12) Virginia Polytechnic & State University
13) Piedmont Community College
14) J. Sargeant Reynolds Community College

5.0 Surveillance Requirements

a) The following tests were performed on a monthly basis as required by the Technical Specifications.
   1) Operational checks of the ventilation duct, personnel door, truck door and emergency exit cover.

b) The following tests were performed at intervals not exceeding six months.
   1) Visual inspection of gaskets on personnel door, ventilation duct and truck door.
   2) Calibration checks of source range, intermediate range, power range, linear power, core gamma monitor, bridge radiation monitor, reactor face monitor, duct argon monitor, constant air monitor, pool level monitors, pool temperature monitors, core differential pool temperature and primary flow.

c) The daily checklist, which is completed when the reactor is to be operated, provides for checks on all of the required scram systems associated with the reactor.

d) The emergency cooling system was tested during the month of September 1984. The results are as follows:

	S.E. Tank	S.W. Tank
Required flow, gal/min	11.0	11.5
9-24-84 Actual flow, gal/min	12.3	13.5

The flow continues to be greater than that required by the Technical Specifications

Data on all of these tests and calibrations is on file at the facility.

e) Pool Make-up

During the calendar year 1984 make-up water to the UVAR pool averaged 84.5 gallons/day.

6.0 Unplanned Shutdowns

Following is a list of unplanned shutdowns on the UVAR reactor during the calendar year 1984

1-3-84 Scram - Instrument noise on Power Range #2
1-5-84 3 Scrams - Instrument noise on Power Range #2
1-8-84 Scram - Instrument noise on Reactor Face Monitor
1-17-84 Scram - Instrument noise on Power Range #2
1-26-84 3 Scrams - Instrument noise on Intermediate channel period - power was steady.
2-1-84 2 Scrams - Noise on Power Range #2
2-8-84 Scram - Noise on Reactor Face Monitor
Scram - High reading on bridge monitor while moving fuel at far end of pool
2-14-84 Scram - Power Range #2 - caused by malfunction of linear recorder in servo.
2-22-84 Scram - Power Range #1 - caused by malfunction of linear recorder in servo.
2-28-84 Scram - Intermediate period - moving SB-Be source near detector.
3-7-84 Scram - Operator forgot to move range switch when going above 200 kw.
Scram - Power Range #2 - reactor was operating at 200 kw.
3-26-84 Scram - Noise on Reactor Face monitor.
4-17-84 Scram - Intermediate Period - moving SB-Be source near detector.
Scram - Power Range #2 - moved range switch too early while decreasing power.
4-28-84 Scram - Range switch indication.
4-30-84 Scram - Noise in Power Range #2 while moving rods.
5-8-84 Scram - Intermediate Period when moving source near detector.
5-10-84 Scram - Intermediate Period when moving source near detector.
5-23-84 2 Scrams - Loss of Building Power.
5-25-84 Scram - Noise in Bridge Radiation Monitor.
6-1-84 Scram - Loss of Power in Secondary Console.
6-5-84 Scram - Loss of Building Power.
6-7-84 Scram - Noise in Bridge Radiation Monitor.
6-9-84 Scram - Loss of Building Power.
6-11-84 3 Scrams - Noise in Bridge Radiation Monitor.
7-6-84 Scram - Bridge radiation monitor when sample was removed from rabbit.
7-6-84 Scram - Loss of Building Power during storm.
7-11-84 Scram - Noise in console - indicated primary pump off although pump was running.
7-20-84 Scram - Noise while moving regulating rod.
8-6-84 Scram - Noise in Intermediate period channel.
8-8-84 Scram - Loss of building power.
8-13-84 Scram - Loss of building power.
2 Scrams - Noise in Range switch.
Scram - Noise in Power Range #2.
8-22-84 Scram - Power Range #1 while adjusting detector position.
10-9-84 Scram - Noise in console.
Shutdown - Rod #3 dropped.
10-10-84 Scram - Noise in Power Range #2.

10-23-84 Scram - Building Power failure.
10-24-84 Shutdown - Rod #3 dropped.
10-30-84 Shutdown - Rod #3 dropped.
11-15-84 Scram - moving Sb-Be source near detector.
11-20-84 Scram - Noise in Power Range #2.
12-18-84 Scram - moved power range switch.
12-21-84 Scram - noise in Bridge monitor.
Scram - noise in Power Range #2.

B. CAVALIER Reactor

During the calendar year 1984 the CAVALIER reactor was operated as follows:

	Hours Operated	Watt-hours
First Quarter	20.5	379.5
Second Quarter	5.0	4.5
Third Quarter	0	0
Fourth Quarter	0	0
TOTAL	25.5	384

The CAVALIER was unloaded on May 4, 1984 in order to utilize the fuel elements in the UVAR reactor, which was operating around the clock. New fuel elements were received during the fall and we presently plan to reload the CAVALIER during the month of January, 1985.

Application for renewal of the CAVALIER operating license, which was due to expire on July 30, 1984, was submitted to the NRC on June 22, 1984. Mr. R.E. Carter of the NRC and three individuals from Los Alamos Laboratories were at this facility on November 7, 8 and 9, 1984 to review our license renewal. The review is still in progress.

1.0 Rod Drop Tests

Technical Specification requirements:
magnet release time < 100 milliseconds
free drop time < 700 milliseconds

Date	Rod	Rod position inches)	Voltage	Magnet Release Time (msec)	Free Drop Time (msec)	Total Drop (msec)
2-23-84	1	26	35	97	470	567
	2	26	35	33	438	471
	3	26	35	77	528	605
	4	26	35	92	451	543

The rod drop times will be re-measured when the CAVALIER reactor is reloaded and prior to achieving criticality.

2.0 Maintenance

a) The following maintenance was performed on the CAVALIER system during the calendar year 1984

9-20-84 Replaced all coaxial cables and most module and drawer connectors on source range #1 & #2 channels and Log N channel. Also installed drawer slides on these systems.

10-30-84 High voltage low on radiation area monitor #2 (demineralizer pit). Replaced all filter capacitors and checked out system.

11-1-84 Irratic indication and constant 5 second period on Source Range #1. Replaced oscillator module and pulse amplifier and connector. System calibration o.k.

b) During the calendar year 1984 make-up water to the CAVALIER tank averaged approximately 2.5 gallons/day.

3.0 Operating Procedures

Section 12 on Emergency Procedures was revised and expanded in January, 1984.

4.0 Surveillance Requirements

The following tests and calibrations were performed on the CAVALIER system during the calendar year 1984.

a) The following tests were conducted at intervals not exceeding six months.

Calibration of source range channels, Log N channel, Log G channel, linear power channel, pool level monitor, radiation monitoring system and boron concentration in ARIS system.

All of these tests and calibrations were within limits required by the Technical Specifications.

b) Flow tests of the ARIS system were performed as follows:

Date	Time to empty tank
5-24-84	32 seconds
11-28-84	30 seconds

These tests were well within the required time of approximately one minute.

c) Control rod calibrations will be performed when the CAVALIER is reloaded.

d) The daily checklist which is completed when the reactor is to be operated, provides for checks on all of the required scram systems associated with the reactor.

Data on all of these tests and calibrations is on file at the facility.

5.0 Unplanned Shutdowns

The following unplanned shutdowns occurred on the CAVALIER reactor during the calendar year 1984.

1-9-84 scram - noise in console.
1-10-84 3 scrams - noise in console.
1-11-84 scram - electronic noise.
1-12-84 high power scram at approximately 57 watts when leveling off.
1-13-84 scram - noise in console
3-28-84 high power scram at approximately 58 watts when leveling off.

C. Health Physics

a) Atmospheric Release

The following effluent was released to the atmosphere during the calendar year 1984 as a result of reactor operation.

Ar^{41} 8.19 curies based on conservative calculations.

b) Solid Waste

During the calendar year 1984 approximately 61 cubic feet of solid waste was shipped from the Reactor Facility by Teledyne Inc. The activity of the waste was as follows:

Isotope	Activity (millicuries)
Na^{22}	0.007
Na^{24}	0.017
Mn^{56}	0.40
Fe^{59}	0.022
Co^{57}	0.006
Co^{60}	0.022
Zn^{65}	0.013
I^{131}	0.001
Cs^{137}	0.006
TOTAL	0.494 millicuries

c) Liquid Waste

Liquid waste from the regeneration of the demineralizer system was released during the year and diluted with water from the hold-up pond.

	Activity (μci)	Volume (gallons)
First Quarter	559.24	4,468,190
Second Quarter	1061.06	5,016,100
Third Quarter	442.20	1,170,900
Fourth Quarter	101.44	2,235,140
TOTAL	2163.94	12,890,330

The average specific activity released was 4.4×10^{-8} μci/ml.

Samples of the waste tank water and the hold-up-pond were analyzed independently by "Controls for Environmental Polution Inc." of Santa Fe, New Mexico. They performed an isotopic analysis for Iodine-129, Radium-226 and Radium-228. The analysis showed these isotopes to be below their minimum limits of detectability as follows:

Tank Water and Pond Water -	Iodine - 129	$< 1 \times 10^{-9}$ μci/ml
	Radium - 226	$< 0.6 \times 10^{-9}$ μci/ml
	Radium - 228	$< 1 \times 10^{-9}$ μci/ml

based on this analysis and the provisions of 10 CFR part 20, note to appendix B, table C the MPC for our liquid effluent release is 1×10^{-7} µci/ml.

3.0 Personnel Monitoring

During the calendar year 1984 approximately 150 personnel including faculty, staff and students were monitored by film badges supplied by the R.S. Landauer Company. The highest exposures were to five staff members directly involved with the operation of the facility and the handling of samples used in activation analysis.

	Whole Body Dose (as of 10-31-84)	Extremity Dose
Individual A	420 mrem	30 mrem
Individual B	330 mrem	410 mrem
Individual C	330 mrem	1170 mrem
Individual D	280 mrem	1600 mrem
Individual E	150 mrem	1700 mrem

During the year the facility had 2266 visitors. These visitors were monitored with direct reading dosimeters and received no significant exposure.

D. Miscellaneous

1) Formal meetings of the Reactor Safety Committee were held on the following dates:

February 24, 1984	October 26, 1984
April 30, 1984	December 12, 1984
May 21, 1984	December 19, 1984
July 25, 1984	

A subcommittee of the Reactor Safety Committee performed audits of the facility operations during the months of January, May and September 1984.

2) a. An NRC inspector visited the facility on October 1st, 2nd, 3rd 1984 to inspect our Radiological Safety Program. Several apparent violations were found. As a result of this inspection an Enforcement Conference was held at this facility on October 22, 1984. As of this date we have had no formal report on either the inspection or the Enforcement Conference.

b. An ANI Insurance Inspector visited our facility on December 17, 1984.

3) a. A revised Emergency Plan for this facility was submitted to the NRC on July 12, 1984. The plan was approved effective October 3, 1984. An extension period to have effective implementing procedures in place was requested and granted. The deadline for these implementing procedures is April 3, 1985. The procedures are being written and we expect to have them reviewed and approved by our Reactor Safety Committee before this date.

b. 1) An evacuation drill of the facility was held on October 10, 1984.

2) An emergency drill that involved a simulated accident with two injured and contaminated victims was held on November 8, 1984. The drill involved the reactor staff, Health Physics Personnel, the University Police, the Local Rescue Squad and the University Hospital Emergency Room. The Hospital initiated their Radiation Emergency Plan when notified of the "accident" and the "victims" were transported to the emergency room by the local rescue squad, assisted by the U.Va. Police. the NRC office at Region II in Atlanta was notified in advance of the drill and they sent three NRC personnel from the North Anna Power Plant to observe.

4) A new pneumatic rabbit system was installed in the UVAR reactor and a pneumatic transfer system for transporting samples from the reactor room to the counting room was put into operation during the year. These systems were reviewed and approved by the Reactor Safety Committee.

5) a) Twenty four spent fuel elements were shipped to Savannah River for reprocessing on June 4, 1984 and June 8, 1984.

b) Twenty seven new fuel elements were received during the year from the Babcock and Wilcox Company. These elements were fabricated by Atomics International and were shipped to B&W when they took over the aluminum fuel element business.

E. Personnel

1) Dr. J.S. Brenizer resigned as Director of the Reactor Facility on June 30, 1984. Dr. R.U. Mulder became Director effective July 1, 1984.

2) Reactor Operator exams were given during the month of April, 1984 and resulted in licensing of three reactor operators.

3) The Environmental Health and Safety office assigned Mr. J.E. Henderson as Health Physicist for the Reactor Facility on May 1, 1984. He is assisted by a full time health physics technician.

This report has been reviewed and approved by the Reactor Safety Committee.

Sincerely,

J.P. Farrar

J.P. Farrar, Reactor Supervisor
U.Va. Reactor Facility

cc: Office of Inspection and Enforcement
Region II
Atlanta, Georgia